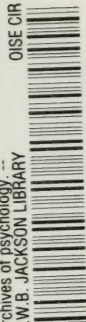


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# A Qualitative Analysis of Behavior Following Cerebral Lesions

Diagnosed as Primarily Affecting the  
Frontal Lobes

BY

AARON B. NADEL, Ph.D.

ARCHIVES OF PSYCHOLOGY

R. S. WOODWORTH, Editor

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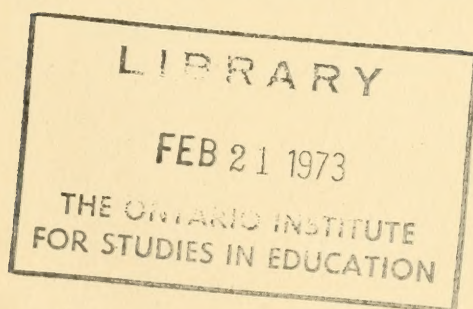
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## CHAPTER I

### INTRODUCTION

Until recent years, there has been an inadequate integration of clinical medicine and psychological method. The psychological experiment has been found most productive in the concepts of the neuroses and the psychoses, where it has obtained a high degree of recognition. Recent inquiry has recognized the fact and revived the methodology which would demonstrate that changes of behavior due to functional deviations caused by structural changes are not to be investigated by the methods of clinical medicine alone, but must include experimental studies of behavior.

The basic approach towards an investigation of this type may be formulated after the method suggested by J. Hughlings Jackson (35), when dealing with individuals suffering from a structural change of the brain. Jackson's explanation of pathological behavior considers two general elements which exist simultaneously in the behavior of the diseased central nervous system: negative elements, or "losses of adjustments of the organism" (due to the loss of function of higher centers), and positive elements, or "symptoms" (due to the functioning elements of lower centers in themselves unaffected). This basis may be seen as fundamentally neurological.

Irritability, unreasonableness, fault finding, complaining, and many other characteristics of those physically ill need to be interpreted to be understood for they cannot be taken at their face value. According to William A. White (81), they do not mean what they appear, on superficial examination, to mean. These patients are talking in a different dimension, their language is conditioned by motives which we know either little or nothing about, especially since in our own experience we have no need for them, or we have not been thrown back to their use. Their language must literally be translated. Generally, we might say that the diseased utilize a language which coincides with thinking, with concepts, with ideas that are on a lower level, or at least of a different order of abstraction.

Mental symptoms occur in a great variety of conditions of nervous disease such as cerebral hemorrhage, embolism and thrombosis, paralysis agitans, multiple sclerosis, tumor and meningitis. They do not differ essentially in symptomatology, the definite findings of an organic reaction, usually progressive in type, being present in varying degrees. In general, it may be remarked that



the mental symptoms associated with organic brain disease are scarcely ever specific and diagnostic in respect to the locus of the disease. The greatest controversial question has revolved about whether or not a lesion of the frontal lobes of the brain will lead to mental changes.

In the present discussion, the psychic changes which arise are those following a lesion of one type or another, of the frontal brain, affecting the pre-frontal areas.

#### THE NEUROLOGICAL APPROACH

In the older studies, frontal lobe lesions were sometimes reported to show no mental or behavior symptoms: Welt (79), Bastian (4), Schafer (68), Knapp (41) and Franz (23). Welt, however, did describe character changes in this condition, but these changes were not present in all her cases. More commonly, however, some mental change was noted by the clinician, as "mental impairment or dementia," Jastrowitz (39) 1888; "dullness, loss of attention and memory, loss of spontaneity, indifference to surroundings," Williamson (83) 1896; and "mental enfeeblement, loss of memory, loss of power of attention, personality changes," Bramwell (12) in 1899. The clinical approach received considerable substantiation, at this time, from workers in the experimental field, Hitzig (34), Ferrier (19), Bianchi (5), Flechsig (21, 22) and Bolton (9).

There are different causes for the variance of opinion which exists in regard to the relationship of the frontal lobe and mental symptoms. These causes have been summed up in a paper by Goldstein (28): (1) Inadequate attention has been paid to the site, extent and nature of the lesion. Small circumscribed lesions may exist without any mental changes being unearthed by the existing methods of examination, especially if the lesion should be located in the right half of the brain. However, it should be remembered that mental disturbances should not then be alone referred to the left side of the brain, because cerebral dominance is subject to individual disposition. Another element to be considered is the possible microscopic damage of tissue, which may extend beyond the gross lesion more than is known in different types of disease. (2) Differences in the manner of investigation. Too frequently negative results have been offered because no apparent mental disturbance was noted. It should be borne in mind that the types of mental change found in frontal lobe lesions are such that they may be easily over-



looked. Thus, more accurate and more thorough methods of examination are desirable.

On these accounts, a great deal of the older literature is of little value for answering the question of whether such disturbances occur in lesions of the frontal lobe, and what form these disturbances may take. At present we can only question the value of the greater number of these investigations until more fruitful and more definite examinations are made. These criticisms still apply to the more recent studies despite the larger samples of clinical material.

More recent studies covering extensive case material have not completely overcome these objections. Feuchtwanger (20), in a comparison of two hundred cases of frontal lesions with an equal number of cases showing lesions elsewhere, Dandy (15), Gardner (24), and O'Brien (54), investigating cases with complete right hemispherectomies, did not find any relationship between mental symptoms and frontal lobe injury. Dercum (17) and Whitney (82) agreed with other clinicians (55, 31, 69, 50) in placing emphasis on mental deterioration, etc., existing in cases of frontal lobe tumors. Moersch (48) derived "a frontal lobe syndrome." Donath (18) offered results criticising the methods of examination and stating that the patients showed some form or another of "idiocy," associated with a disease of the frontal lobe. The monograph of Baruk (3) is one of the most valuable on this subject. After a clear exposition of the difficulties of coordinating cases from the literature and of attempts to base psychic disturbances on localization, he divided the mental symptoms of tumors of the frontal lobes into three classes: (1) mental impairment, (2) changes of character and emotion, (3) changes of spatial orientation. Additional material substantiating these results has been offered by Schwab (70), Brain and Straus (10), Sachs (66, 67), Strauss and Keschner (73), Voris, Adson and Moersch (75), and Shamboorov (72).

Fully cognizant of the need for penetrating beyond the "clinical" methods, a number of investigators included psychological tests and methods, Poppelreuter (62), Goldstein (27), Pfeiffer (58), Peritz (57), and Berger (7). This group of investigators found a positive relationship between mental symptoms and affections of the frontal lobes of the brain. The studies of Penfield and Evans (56), and of Brickner (13), well demonstrated the utility of psychological aids in extensive clinical investigations.

After a discussion of these studies, it appears of value to mention that most of the investigations favoring the correlation of mental

symptoms and frontal lobe affection, just as those studies unfavorable to this relationship, are not free from criticism. What is needed in the first instance is a qualitative description rather than a test score. It is of greater value to obtain the existing facts, than the interpretations of mental symptoms obtained from friends and relatives or short interviews. The positive results in such investigations are the important ones. Negative results where "nothing" has been found mean very little in solution of this problem. They should act rather as incentives for further research.

Many of the investigators have realized that lesions of the pre-frontal-frontal areas led to symptoms quite uncharacteristic of other regions of the cerebrum, whether due to the presence of destroyed tissue or pressure from other intracranial defects. A number of them, as seen in the previous discussion, have been able to classify the symptoms which have generally been substantiated by others. Many lesions, located elsewhere than in the frontal region, have been known to give symptoms not unlike those found in the frontal area.<sup>1</sup>

#### THE PSYCHOLOGICAL APPROACH

From the psychological point of view, it should be of value to examine first the investigations undertaken in the animal field. Lashley's (45) experiments on the brain mechanisms of rats stated that "the whole implication of the data is that the 'higher level' integrations are not dependent upon localized structural differentiations but are a function of some more general dynamic organization of the entire cerebral system." The recent studies of Krechevsky (44) in respect to variability of behavior in rats have followed the lines begun by Lashley.

Jacobsen (37, 38), however, in primates where the frontal lobes were extirpated (in monkeys and apes, both frontal lobes must be excised before a behavior change will appear; unilateral extirpation does not lead to any discoverable manifestation, mentally) has found that "the operated animal seems more distractible in contrast to the sustained directed behavior of the normal subject. Behavior, instead of being directed by a balance of immediate, recent and temporally remote stimulation, is dominated by present external stimuli and the stable habit systems derived by earlier training . . . the extirpation of the frontal association areas in monkeys and chimpanzees

<sup>1</sup> Studies of Gibbs (26), Strauss and Keschner (74), and Foster Kennedy (40), on mental symptoms with lesions of the temporal lobe of the brain. The extent of microscopic tissue damage, or the effects of pressure factors leading to such mental changes had not been evaluated in these investigations.



causes behavioral disturbances strikingly similar to those described in man after this lesion, namely, a marked reduction in the complexity of behavior."

Animal experiments (11, 36) have pointed out the marked trends towards specialization in function of more restricted cerebral regions as we progress in the phylogenetic scale. In the human form, we have reached the highest level of such integration.

In 1914, Hart and Spearman (32) criticized the views which sought specific defects as the definition of dementia. Their opinion was that mental injury is of a perfectly diffuse character, and constitutes a lowering of the entire intellectual level. They stressed, too, the importance of better techniques of examination to produce those changes in performance which are difficult to elicit, because of the reinforcement of the rest of the cortex in support of the injured areas, as the particular defect arising from the latter is especially difficult to detect.

Another study tending to point out the more general aspects of dementia is that of Moore (52). He found that immediate memory, the power of retention, and perception, have a great tendency to deteriorate together. He also concluded that this tendency was not universal, because occasionally, one of these mental processes deteriorates out of all proportion to the others.

Goldstein (28), in a series of investigations of patients with cortical injuries, found that the spontaneous behavior of those patients was determined more by sensory stimulation of the existing objects than by a principle formulated by the participant. Normals, according to Goldstein, have the ability of either formulating a principle determining their attitude of selection, or of allowing the sensory attributes to determine selection. The normal is capable of both forms of behavior. He is also able to shift voluntarily from one form to the other. The fundamental change in the behavior of patients with cerebral lesions is that consisting of a loss of the ability to select a pre-determined principle of choice, what Goldstein calls "abstract behavior." "In the abstract attitude we are not directed toward an individual object but toward the category of which the object represents itself as an accidental example and representative of the category. This may be called the categorical attitude. The concrete attitude is realistic. We are directed more toward the concrete thing in its particular uniqueness." (29) This disturbance, the loss of the "abstract attitude" in patients with cerebral lesions, may be found in all fields of performance. Thus, Goldstein also

views mental change as a more general change of the organism, not only as a change of certain specific faculties.

Weigl (76), following the lines suggested by Goldstein, compared patients with cerebral injuries and normal adults in a study of complex behavior. He found that the patients utilized momentary sensory stimuli as means for bringing the test objects together. These test objects were cardboard figures which could be brought together either by color or form. Some of the patients selected by color, some by form. Those patients who did use form, did so on a manipulative basis, that is, they made their selections by placing those objects of the same form one on top of the other. They were unable to give any reason for their choice. A second part of the experiment, designed to test the ability to shift showed that the patients could not find a second basis for selection, but the normals could do so with no difficulty whatever.

Weigl also used an object sorting test, consisting of many types of classification: color, form, materials, use, repetition, etc. His subjects were patients with cortical lesions, normal adults and normal children. Although this test gave greater opportunity for variance in modes of selection, there existed, on the part of the patients and the children of 4 to 6 years of age, a definite tendency to group pairs of objects in a rather restricted concrete fashion. By this concrete grouping is meant grouping for use in a particular situation which was familiar to the subject. In the normals, however, Weigl found a tendency towards two types of behavior. One was that of the concrete grouping, mentioned above; the second was that of large groups or categories of objects. The normals were also able to shift their modes of selection upon demand, the patients and young children were unable to do so.

Similar studies were recently completed by Bolles (8), and Bolles and Goldstein (8a), using, in addition to the tests used by Weigl, other tests such as the Color-Sorting Test, and Kohs Block Designs. Here patients were classified as dementia praecox of the different types, and feeble-minded children. They compared their results with those obtained from normal children of comparable mental ages. Their results fit into the type of results obtained by both Goldstein and Weigl; that there are two general forms of behavior, but both forms are expressed only by normals. Their patients presented only the "concrete" attitude of behavior, showing a loss of the higher form or "abstract" behavior.

Research in the field of the psychoses has been stimulated with



a great deal of effort to explain the term "mental deterioration" from more fundamental approaches. Some investigators, as Wentworth (80), Pressey (63), Wells (78), and Dearborn (16), attempting an item analysis of the Stanford Binet arrived at a measure of scatter which was felt to be indicative of deterioration. Shakow (71), however, demonstrated that such scatters were actually unreliable because the comparisons were made with tests given to normal children, not adults.

Other studies, such as Babcock (2), tried to measure deterioration by comparing the score made on a vocabulary test (a pre-morbid acquisition of the patient) and scores on new tests emphasizing learning and speed. Although she did find reliable differences between her normals and patients, emphasis was placed on the inability to fixate and recall new data in terms of learning and speed. This latter factor induces us to consider the importance of a more thorough analysis of the underlying elements behind difficulties of fixation and recall. What is lost which prevents fixation or retention of newly learned material? It is believed that Babcock's emphasis on the quantitative elements of measurements of deterioration may have masked the existence of the more fundamental factors. Further studies in the investigations of deterioration or of the higher thought processes in schizophrenia may be found elsewhere. (8, 64).

In the fields of the organic brain lesions, a number of other studies have been carried out by many investigators. The psychological approach to behavior in such cases has been fully reported in articles by Ackerly (1), Miles (49), German and Fox (25), Malamud and Palmer (47), and the book of Weisenburg and McBride (77). Since the methodology and approach of the present author differs markedly from the methods of these authors, the reader is referred to the above material for further consideration.

## CHAPTER II

### THE PROBLEM

In abstracting the investigations previously reported, it has been noted that such expressions as "loss of synthetic ability," "inability to serialize," "loss of abstract thinking," "a lack of approach to imagined things," "idiocy," "dementia," "psychoses with organic diseases," "childishness," and many other similar terms have been used to describe the behavior resulting from a change due to an organic lesion interrupting those areas which subserve higher mental functions. In general, there is a tendency for all these concepts to describe the same essence of behavior, yet the interpretations vary. Whether or not we agree on the use of terms, I believe to be unimportant. The significance lies in the fact that changes do occur, that these changes appear to follow consistent patterns, both in the one patient, as well as in many patients. Since, according to a consensus of opinion among the investigators, they occur following injury to the frontal lobes of the brain, they are such behavior changes which demand further clarification.

The present study was undertaken with the purpose of determining whether or not such consistent behavior patterns could be determined and described in patients with lesions involving the frontal lobes of the brain and, if so, what forms these behavior patterns take. It was believed that the better method was to use those tests which were independent of speed and whose prime concern was the study of the more spontaneous behavior of the individual in reacting to specific stimuli. A second factor under consideration was: if there were such behavior patterns, could they be differentiated from the patterns of behavior of individuals without such organic involvement of the brain?

#### APPROACH

The methods of approach were qualitative in nature rather than quantitative. The very nature of these methods demands a thorough study of the minutiae of reaction. Because of this important factor, stressed by Goldstein (28), in investigations with patients suffering from organic brain disease, it was considered more valuable to pursue a thorough investigation with a comparatively small group of subjects.

The subjects of this experiment were investigated by means of



a test battery to determine the possible existence of a behavioral pattern or patterns which could be accurately described and compared to the behavior of a control group on the same tests and tasks. To ascertain the ability of understanding simple verbal instructions, a short test for "Following Directions"<sup>1</sup> was administered to all subjects. In this test, the group of normals showed no deviations in any of the responses, which could be construed as errors. The experimental group, in some instances, did show a small amount of error, which varied with the condition of illness of the individual. On the whole, it was the more severely deteriorated individual who erred; his errors being confined to the group of directions calling for two different tasks to be performed, given as a single instruction. Table 1 shows the responses of both groups recorded in terms of the number of correct responses. It is important to note that only three cases of the experimental group, including those markedly deteriorated, failed to show success when a single item of the task was asked of them. In the severe cases, where the two-task situation was failed, the neurologists consider this failure as part of the disease condition: the difficulty of assimilating two items simultaneously being due to a mental change.

TABLE 1\*  
SCORES OBTAINED IN FOLLOWING DIRECTIONS TEST

<i>Experimental</i>			<i>Control</i>		
<i>Subj.</i>	<i>Single Items</i>	<i>Double Items</i>	<i>Subj.</i>	<i>Single Items</i>	<i>Double Items</i>
1 .....	10	5	1 .....	10	5
2 .....	10	5	2 .....	10	5
3 .....	10	5	3 .....	10	5
4 .....	10	4	4 .....	10	5
5 .....	9	5	5 .....	10	5
6 .....	10	4	6 .....	10	5
7 .....	10	5	7 .....	10	5
8 .....	9	4	8 .....	10	5
9 .....	10	4	9 .....	10	5
10 .....	10	5	10 .....	10	5
11 .....	9	3	11 .....	10	5
12 .....	10	5	12 .....	10	5
13 .....	10	3	13 .....	10	5
14 .....	10	5	14 .....	10	5
15 .....	10	5	15 .....	10	5

\* Scores recorded here are in terms of the number of items responded to correctly. The total items of the test consist of 10 single items and 5 double items.

<sup>1</sup> Test used by neurologists in aphasic studies. Cf. Weisenburg and McBride (77.)

The Following Directions Test is not a part of the test battery. This data was included to meet the criticism that the peculiar responses of the experimental subjects were the consequence of an inability to understand the instructions of the tests administered. The results demonstrate that the disability is not one of misunderstanding the instructions, but due to other factors.

The battery of tests presented to the subjects consisted of the Kohs Block Designs, the Color-Sorting Test, the Stick Test, the Feature Profile, and the Rorschach Ink-blot Cards. The method of presentation of the individual tests and the results for each test will be offered in a succeeding chapter. We believed it better to emphasize performance responses rather than a group of verbal responses. Language handicaps may be misleading in patients who have not had sufficient educational facilities, or to whom English is not the native tongue, and speed factors may be a hindrance for those with paralyses or pareses of one or another limb.

#### SUBJECTS

The subjects under investigation in this study consisted of thirty patients, all of whom were patients of the Neurological Service of the Montefiore Hospital.<sup>2</sup> The following tables (Tables 2 and 2a) present a summary of the individual cases studied.

From the tables it will be noted that both the control and experimental groups offer comparable diversity in age, occupation and type of illness affecting the nervous system. The experimental group consists of patients who were diagnosed by the neurologists as having a lesion showing a damage of the left or both frontal lobes, and who were said to show some form of mental deterioration. The control group consists of patients who were diagnosed as having an affection which did not appear to involve the frontal lobes, and who showed no clinical manifestations which would point to the existence of deterioration, according to the opinions of the neurologists.

The diagnoses which were based upon encephalographic or operative findings presumably offer no doubt as to frontal lobe involvement in these cases. The cases where diagnosis was determined by clinical methods alone invite the criticism that complications may arise due to involvement of more than the frontal lobe areas. In these cases,

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<sup>2</sup> There was a single exception, a patient of the Brooklyn State Hospital, who was included in the experimental group because of an isolated lesion of the left frontal lobe, particularly of Broca's area and surrounding tissue. The writer is indebted to Dr. J. Marmor for permission to administer tests and use the information.



TABLE 2\*  
STATUS OF SUBJECTS UNDER INVESTIGATION

<i>Experimental Group</i>						
No.	Subj.	Sex	Age	Occup.	Diagnosis	Determ. of Diagn.
1	R.W.	F	36	Soc. Worker	Aneurysm, Left Frontal Lobe	Post-oper.
2	A.S.**	F	15	Student	Degen. Dis. of both Front. Lobes & Cerebell.	Clinical
3	E.S.**	F	17	Student	(same as Case 2)	Clinical
4	R.S.	F	42	Housewife	Tumor, Left Frontal Lobe	Post-oper.
5	P.R.	F	59	Housewife	Degen. Dis. of Both Frontal Lobes	Clinical
6	E.K.	F	44	Housewife	Vascular Dis. Both Frontal Lobes	Clinical
7	A.H.	F	52	Housewife	Tumor, Rt. Frontal Lobe, pressing Left Lobe	Post-oper.
8	M.A.	M	38	Telegrapher	Vascular Dis. Left Frontal Lobe	Clinical
9	A.S.	M	30	Furrier	Tumor, Left Frontal Lobe	Post-oper.
10	A.R.	M	37	Salesman	Multiple Sclerosis, plaque in Left Frontal Lobe	Clinical
11	B.R.	M	43	Plumber	Vascular Dis. both Frontal Lobes	Encephalogram
12	T.K.	M	16	Student	Degen. Dis., Frontal Lobes and Cerebell.	Clinical
13	L.J.	M	42	Furrier	Tumor, Left Frontal Lobe	Clinical
14	V.T.	M	45	Lawyer	Vascular Degener., Left Frontal Lobe	Encephalogram
15	H.S.	M	53	Business Man	Cerebral Arteriosclerosis, both Frontal Lobes	Encephalogram

\* The numbers, selected to designate the particular case in each instance, refer to the same individual in all tables presented.

\*\* Cases 2 and 3 are siblings with the same disease.

TABLE 2a\*  
STATUS OF SUBJECTS UNDER INVESTIGATION

Control Group							
No.	Subj.	Sex	Age	Occup.	Diagnosis	Determ. of Diagn.	Length of Illness
1	R.D.	F	35	Housewife	Tumor of Nasopharynx	Post-oper.	6 mos.
2	M.K.	F	14	Student	Muscular Dystrophy	Clinical	1 yr.
3	M.J.	F	55	Housewife	Tumor of Cauda Equina	Post-oper.	2 yrs.
4	M.M.	F	28	Housewife	Idiopathic Epilepsy	Encephalogram	3½ yrs.
5	A.R.	F	21	Clerk	Tumor, Left Parietal Lobe	Post-oper.	3 mos.
6	R.W.	F	56	Housewife	Multiple Sclerosis, Cervical spine	Clinical	6 yrs.
7	B.C.	F	24	Housewife	Multiple Sclerosis, Cervical spine	Clinical	2 yrs.
8	A.S.	M	28	Mechanic	Hemiatrophy, left side of body	Encephalogram	8 yrs.
9	A.W.	M	55	Restaurant Business	Neuro-syphilis involving Cerebellum	Clinical	1 yr.
10	R.O.	M	37	Mechanic	Psychoneurosis	Clinical	1 yr.
11	W.M.	M	44	Weaver	Tumor, Left Parietal Lobe	Post-oper.	6 mos.
12	G.D.	M	24	Shipping Clerk	Poliomyelitis, chronic	Clinical	4 yrs.
13	E.F.	M	31	Butcher	Tumor of blood vessel, Right Parietal Lobe	Post-oper.	2 yrs.
14	E.L.	M	35	Factory Worker	Tumor of the 3rd Ventricle	Ventriculogram	3 mos.
15	C.D.	M	46	Cook	Post-traumatic Psychoneurosis	Clinical	1½ yrs.

\* The numbers, selected to designate the particular case in each instance, refer to the same individual in all tables presented.



the strict localization of the disease processes must be held somewhat in abeyance until further proof (autopsy) is furnished.<sup>3</sup> The diagnosis in each case was made by at least three competent neurologists. The present writer, as a psychologist, is rather interested in the mental accompaniments of nervous diseases, and has confined himself to that task. Careful examination of the data from the two sub-groups of experimental subjects, those whose diagnoses were determined by encephalogram or by operation (Nos. 1, 4, 7, 9, 11, 14 and 15), and those whose diagnoses were determined clinically, fails to show any differences in any of the tests.

A second criticism which may arise bears on the dependence of the neurological diagnosis of frontal lobe involvement upon mental symptoms. This study may be considered as a verification of the presence of these mental symptoms, here evaluated by specific tests.

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<sup>3</sup> A review of the findings in a recent paper will demonstrate the co-existence of mental symptoms and marked pathology in the frontal lobes with concomitant disease of other areas of the brain. *Akelaitis, A. J.* Hereditary form of primary parenchymatous atrophy of the cerebellar cortex associated with mental deterioration. *Amer. J. Psychiat.* 1938, 94: 1115-1140.

## CHAPTER III

### TESTS AND RESULTS

#### MODIFICATION OF THE KOHS' BLOCKS TEST

The Kohs' Blocks Test (42), was originally created to serve as a performance test which would act as a supplement to the verbal intelligence tests administered to children for determination of intelligence levels. Kohs standardized this test as a series of tasks of apparently increasing difficulty, which he scored in terms of the time needed to complete the design successfully, and the number of moves made. It is interesting to note, after extensive use of this test with various types of individuals, that Kohs paid no attention to the types of responses or the types of errors, but strictly limited himself to purely quantitative measures. Of greater value, perhaps, is the fact that those individuals who have undergone mental change because of organic interference tend to show marked alterations in the ability of perceiving and organizing the relationships of the blocks to the extent that the observer was amazed at discrepancies from the original designs when such alterations were first noticed.

The original designs used in this test are exactly one-fourth the size of the completed block model. (For our purposes, the original designs on the small cards shall be called Set A.) It is necessary that the subject break down the presented design into its component parts in order to achieve a correct solution. This may be done by either of two approaches: 1) An analysis of the design, and the placing of the blocks one at a time in accordance with this analysis; 2) By trying to reproduce the "figure" suggested by the design. Our results will show that the normal adult may well use either or both of these methods in order to achieve the necessary solution.

#### PROCEDURE

Following the method of instructions utilized by Kohs (42), the subject was shown the blocks, the colors on the different sides of these cubes, and was told that all blocks were identical. A sample design was placed before him, and he was asked to make this design with the blocks given him, using all the blocks. The first sample design was all red. The fact that each subject's response was a move to turn at least one red side of the block uppermost in following the design is significant of his ability to follow instructions. The use of a single block, in some cases, instead of the four



blocks, is rather an element contained in the subject's attitude towards the task. Should he succeed in this task, the next sample design was proffered with similar instructions "to use all the blocks and make this design." With success in this task, the subject was then presented, in order, with each of the designs of the series up to and including Design X. It was found unnecessary to go beyond this latter design because the use of even 9 or 16 blocks allowed for great difficulty to the subjects, and would have increased their errors markedly. However, if the subject failed to reproduce successfully any of the designs, the following sequence was resorted to after a preliminary investigation to determine the value of each of the succeeding sets of designs utilized. In the modifications, a comparable set of designs was constructed, this time of exactly the same size as the completed block model. (The original size, as mentioned above, was a design one-fourth the size of the completed model.) Thus, if the subject should fail the design of set A, he was then presented with the design of set B (of the same size as the block model when completed). Should he be unable to solve the design now, he was then presented with a third design, this time also of the same size as the completed block model, and containing lines drawn through the design in order to delineate the outlines of the blocks themselves. This was set C of the series of presentations of the figures. This method of presentation, however, did not always lead to a successful response, and an additional set of designs was presented. This time, the design was made by a model consisting of the blocks themselves, which the subject was to duplicate by the blocks he used for his reproduction. This type of presentation we called set D. Should he fail the design at this point, he was presented with 4 designs, made of blocks, one of which was correct, the other three incorrect. He was asked to select the correct design from the group.

### RESULTS

The records taken by the examiner acted as the protocols of the testing periods. They were taken so that every move made by the subject, in reacting to a design, was recorded. These protocols were then analyzed to determine where success took place, and what type of solution was utilized by the subject in each respective design. The criteria for determining what means the subject used in his solution were dependent upon his actual performance and his verbal explanations. A typical example of the procedure followed is illustrated:

Case 11, B. R. Design II, Design III,	small card: success.
	small card: failure.
	large card: failure.
	large, lined card: failure.
	block model: success.

Upon completion of the protocols, it was found that some arbitrary set of symbols would be valuable to aid in scoring the responses. To assist in the analyses of the protocols, the following set of symbols was utilized:

(1) The symbol A was given to a successful response when each block was used in an analytic manner to construct the design, in response to the small designs, set A.

(2) The symbol A' was given to a successful response when the subject was attempting a solution by trying to put together the "figure" suggested by the design in response to the small designs, set A.

(3) The symbol B was given to a successful response to the large, unlined designs, set B.

(4) The symbol C was given to a successful response to the large, lined designs, set C.

(5) The symbol D was given to a successful response to the block model, set D.

(6) The symbol Rec. refers to the successful recognition of the particular design in the block model. A multiple choice arrangement was constructed of four sets of blocks which included the subject's own incorrect response, which was to be compared to the original block model. If the subject selected the correct design from the group, he was given Rec. credit.

(7) The symbol Inc. was given when there was neither success, nor recognition of the correct solution when placed within a group of incorrect models, and compared to the block model of the design.

This particular series was followed because it was learned that a graded series of decreasing difficulty for the patient was created by this arrangement. Although this particular series is a graded one, insofar as difficulty is decreased, it must by no means be considered a series of equivalent steps of difficulty (*cf.* Bolles (8)). It was learned that a subject failing one of the later sets, such as C or D, could never succeed in set A or B of that design. Also, a success on set A of the design was found to be prophetic of success on sets B, C, or D, of the same design. Thus, the types of presentation were found to form a scale, the succession of which increased the



similarity between the model given for reproduction and the blocks used in making this reproduction.

In Table 3, the results of the experimental group show all the subjects responding successfully more often to the stimuli which are simplified for them. Series A, for example, is solved but 52½% of the time, as compared to the control group successes of 93⅓%. In the experimental group, we find only a single subject who succeeded in the Series A presentations in as many as all but two instances. In the control group, we find only two cases needing as many as two changes from the Series A presentations.

TABLE 3  
INDIVIDUAL RESPONSES TO KOHS' BLOCK DESIGNS  
*Experimental Group*

Subj.	Samples		Test Designs										Set Changes
	I	II	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	A	C	A'	A'	A'	B	C	A	C	A	A	C	5
2	A'	C	A'	A	A	A	A'	C	C	A	A	C	4
3	D	C	A	A	A	A	C	C	A'	A'	A'	C	5
4	A	C	A	A'	A	B	C	A	C	A	A	C	5
5	B	B	A	A	A	A'	A	A'	A'	C	C	C	5
6	B	B	B	C	A'	D	D	D	D	D	INC	INC	11
7	A'	A'	A'	A	A	D	C	A'	D	C	D	REC	6
8	A	A	A	A'	A	A'	A	C	C	C	REC	INC	5
9	A	A	A'	A'	C	A	D	A'	REC	REC	REC	REC	6
10	C	A'	A	A	A	C	C	A'	C	A	C	C	6
11	A'	A	D	A	D	D	REC	REC	INC	REC	REC	INC	9
12	C	C	A	A	A	A	A	A	A'	C	REC	REC	5
13	A	A	A	B	C	D	C	A'	C	C	D	REC	8
14	B	A	A	A	A	C	A	A'	A'	A	B	C	4
15	A'	A	A	A	A	A	A	A	C	A	A	C	2

Table 4, the results of the responses of the control group, shows the marked tendency to solve the tasks presented to the subjects with very little deviation, on the whole, for the group. Only 10 instances occurred where it was necessary to use any of the simplified presentations, and of these 10, 7 of them were confined to Design X, which is the most difficult of the entire group, and involves a shift to the nine blocks instead of the previous four which had been used. Both Tables 3 and 4 give us a graphic picture of the individual differences within each group.

Table 5, summarizing the responses for the two groups of subjects, allows us further penetration into the behavioral activities of our cases. We may note that there is a much greater need, on the part of the experimental group, for "simplification," for lessening the

## QUALITATIVE ANALYSIS OF BEHAVIOR

TABLE 4  
INDIVIDUAL RESPONSES TO KOHS' BLOCK DESIGNS  
*Control Group*

Subj.	Samples		Test Designs										Set Changes
	I	II	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	A	A	A	A	A	A	C	A'	A	A	A	C	2
2	A	A	A	A	A	A	A	A	A	A	A	B	1
3	A	A	A	A	A	A	C	A'	A'	A	A	C	2
4	A	A	A	A	A	A	A	A'	A'	A	A	A'	0
5	A	A	A	A	A	A	A	A'	A	A	A'	A	0
6	A	A	A	A	A	A	A	A	A	A	A	A	0
7	A	A	A	A	A	A	A	A	A	A	A	A	0
8	A	A	A	A	A	A	A	A	A	A	A	A	0
9	A	A	A	A	A	A	A	A	A	A	A'	C	1
10	A	A	A	A	A	A	A	A	A'	A	A	B	1
11	A	A	A'	A	A	A	A	A	A	C	A	A	1
12	A'	A	A	A	A	A'	A	A'	A'	A'	A	A	0
13	A	A	A	A	A	A	A	A	A	A	A	C	1
14	A	A'	A'	A	A	A	A	A	A'	A	A	A	0
15	A'	A	A	A	A	A	A	A	A'	A	A	C	1

TABLE 5  
GROUP RESPONSES TO KOHS' BLOCK DESIGNS  
*Experimental Group*

[illegible]



discrepancy between the design presented and the unit to be completed by the blocks. Among the control subjects, such extra presentations were found to be minimal, and only necessary in rare instances. One striking element may be seen in both groups of subjects. In common to both groups is the tendency to respond to the task presented to them in either of two ways: (1) By breaking down the design into its component block elements, constructing the required design by the single blocks; (2) By following the "figures" created by the design, thus building the "figure" of the design. The latter method may lead to success on some occasions, but the blocks are so arranged that response to the "figure" usually leads to an unsuccessful result. Usually two or three blocks together are needed to complete a "figure." Thus the method of using the single blocks is essential for success.

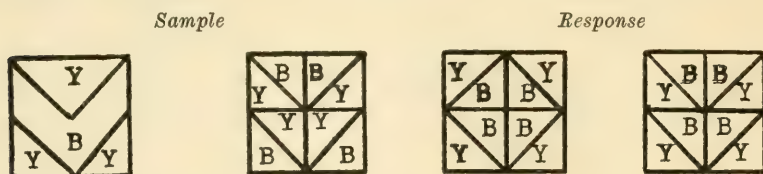
The control group, according to Table 5, appears to prefer the first method. However, it is obvious, too, that they are quite capable, in many instances, of utilizing the second of the methods with marked success. It has been frequently noted that when a subject of the control group uses the second method in his approach to the solution of a design, he may have to shift to the first method of manipulation in order to solve the task successfully. The experimental group also utilizes both methods in solution of the problems, but has a decided preference for the second of the methods. Frequently, the latter subjects use the second method to the extent that they are unable to climb out of the resulting maze which they have created, thus necessitating further aid, by means of the added series of presentations.

Another fact we were able to observe from these results was that the Kohs' arrangement of graded difficulty of the designs does not seem to hold for adults. In both groups, variations were found to show that the original standardization did not take into account the qualitative elements of solving these designs, so that a true gradation of the ascending difficulty does not appear, in actuality, though it may have appeared in the standardized group.

In analyzing the causes for failure in the experimental group of subjects, we found a good deal in common among the entire group. To explain the types of error, a typical case will be offered at the close of each description:

(1) *Impressiveness of the "figure" of the design.* A goodly number of the designs present a figural relationship which appears, from the behavior in manipulation of the subject, to effect his re-

sponses markedly in those situations. For example, Design IV: Case 1.



When the subject was asked what seemed to be the trouble, she responded: "I'm trying to get the point here, the blue one." The fact that the design showed such a figural element was the cause of failure in Series A on this design.

(2) *Impressiveness of color elements*, so that a solid colored side of the cube would frequently be used instead of a two-colored side. For example, Design V: Case 8.



When asked if it were correct, the response was: "Sure, here white, then a red line, a white line, and the red," pointing to each element about which he talked. Urgings as to the exactness of similarity had little effect in leading to any correction of the error, "Sure it's right, it's the best I could do."

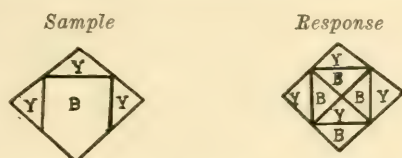
(3) *Inability to utilize the elements of color and position simultaneously*. There was, generally, no difficulty at all in selecting the correct colors, but the very same subjects could not successfully reproduce the correct positional arrangements of these colors. For example, Design II: Case 11.



Inquiry as to correctness led to the following remarks: "It's right, red on top, yellow in the middle, and two blues on the ends."



(4) *Inability to complete the task successfully*, although three of the four blocks had already been correctly placed and the subject was certain he had successfully completed it. For example, Design IX: Case 14.



This patient being afflicted with motor aphasia could not always make clear what he had to say, but was able to acknowledge when he was finished. In the above design, he remarked, "No, no, yes, yep, sure, sure," after a thorough survey of the response and the warnings of the examiner.

(5) *Seeking non-existent color combinations*. In Series A, there are two places where such nonexistent color combinations were sought: Design 2: Case 4.



The accompanying remarks were, "Can't do it, need red and yellow sides." Design VII: Case 10.



(The only manipulation in this reaction was to turn the blocks over and over and over, and finally push them aside.) The patient in this instance replied, "Can't do it, there are no blue and white. Must have blue and white."

The errors mentioned above were rather common among the entire group. Other instances were considered a secondary group of errors, not as widespread in the group but found in more than a single instance.

## THE COLOR-SORTING TEST

The Color-Sorting Test<sup>1</sup> originally utilized by Goldstein and Gelb (30), was recently described by Bolles (8), and Bolles and Goldstein (8a). The identification system of the skeins was changed so that a complete series of the individual hues would be obvious at a momentary glance. For example, in the reds, it was found that there were four distinct shade groups, each of which contained four or five less widely differentiated nuances. These were identified by numbers so that a glance at each skein would tell where the particular skein was located in the series of this hue. RI<sub>2</sub> is the second darkest red in the series, whereas a skein such as RIII<sub>4</sub> was a very light pink, fifth from the lightest of the series. This method of identification was extremely helpful in identifying the relative distance in shade of the successive skeins selected by the subject, and of great advantage in recording the protocols.

The Ishihara Color Spot Test was given to each subject before administration of this test. The procedure of the Color-Sorting Test is as follows:

I. A dark red skein was selected by the examiner and placed before the subject. The subject was asked to select all the skeins which he believed belonged to this sample. If his selection was restricted to a small number of skeins, the examiner then picked out all the other skeins of the same hue, placed them before the subject and asked whether these skeins did not belong to the sample just as did the ones selected by the subject.

II. The same procedure was followed, this time using a light green skein as the sample.

III. Three skeins were placed before the subject. These skeins were chosen so that a choice could be made either by hue or brightness equivalents, or by a complete rejection of these relations. The examiner pointed to the center skein and asked the subject to which of the other two it belonged. After his selection, he was asked to tell why he believed this combination belonged together, and whether the other alternative selection could not be as good a combination. Six arrangements of this type were presented.

IV. The subject was asked to select all the "reds."

V. The subject was asked to select all the "greens."

VI. The subject was presented with two groups of skeins, each

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<sup>1</sup> C. S. Stoelting & Co. The Holmgren Wools, a test used in determining color vision.

containing six samples. One row consisted of a series of a scale of reds, ranging from the lightest to the darkest. The second row contained a series of six hues, red, green, yellow, blue, brown and purple, of equivalent brightness. The subject was asked to select that group which he thought belonged together better. Upon his selection, he was asked to tell why he had made this selection.

# ANALYSIS OF THE DATA

Within the confines of the material presented here, it was found that there are two general approaches in responding to all the tasks presented. There is a restricted type of selection, which is confined to the identical or almost identical shades of the hue presented by the particular sample. This method of selection is most common among the experimental subjects. The second method, which we call the broad basis of selection, is most common with the control group, although instances of the more restricted type of selection do occur with this group of subjects. When this restricted selection is found

TABLE 6

INDIVIDUAL RESPONSES TO COLOR-SORTING TEST, SHOWING NUMBER OF SKEINS SELECTED IN EACH TASK

Subj.	Experimental Group						Subj.	Control Group					
	I	II	III*	IV	V	VI		I	II	III*	IV	V	VI
1.....	7	5	2/6	7	7	B	1.....	20	20	3/6	8	20	A
2.....	4	6	2/6	6	7	B	2.....	10	20	3/6	9	20	A
3.....	6	9	3/6	8	10	A	3.....	7	20	3/6	10	20	A
4.....	6	4	3/6	6	9	B	4.....	10	20	2/6	10	20	A
5.....	6	3	1/6	8	20	A	5.....	8	20	6/6	10	20	A
6.....	3	2	1/6**	9	20	A	6.....	9	20	6/6	9	20	A
7.....	3	7	6/6	8	20	A	7.....	5	7	2/6	8	20	A
8.....	4	9	0/6**	8	5	A	8.....	10	20	6/6	10	20	A
9.....	3	3	0/6**	3	5	0**	9.....	6	9	6/6	11	20	A
10.....	Red-green blindness						10.....	6	20	6/6	9	20	A
11.....	5	6	1/6	4	6	0**	11.....	12	20	4/6	18	20	A
12.....	4	6	3/6	5	8	A	12.....	7	20	6/6	7	20	A
13.....	5	7	0/6**	5	3	B	13.....	2	2	6/6	3	11	A
14.....	3	5	3/4†	20	25	A	14.....	9	20	6/6	10	20	A
15.....	2	3	0/6**	4	8	0**	15.....	7	20	6/6	9	20	A

\* Task III shows responses in terms of the number of hue matchings in six trials.

\*\* These cases refused to make any of the matchings, with a single exception (Case 6), because they believed that none of the presented skeins belonged together in any of the suggested combinations.

† In Task III, this subject refused to complete the task because he believed he had had enough of it. In Task V, this subject had more than the total number of "green" skeins, because he included the yellows (5 of them).

A refers to preference of the hue series in Task VI, and

B refers to preference of the brightness series.



with a subject of the control group, he was presented with the additional shades of the particular hue represented by the sample, and when asked whether they belonged, his response was frequently of this nature: "I didn't select those because I thought you did not want them included. They do belong here, they are reds too." The subjects of the experimental group, however, offered varying reasons for rejection of such added skeins when the same procedure was followed. Of particular interest are the bases of the refusals, which will be presented shortly.

The average differences between the two groups tend to demonstrate marked trends for each group of subjects. Table 6, illus-

TABLE 7  
AVERAGE DIFFERENCES BETWEEN THE GROUPS

Group	No Color Names Used			Color Names Used		
	I	II	III	IV	V	VI
Control .....	7.3	16.	4.2/6	9.4	19.4	A 100%
Experimental* .....	4.3	5.3	2.05/6	6.9	10.6	A 50% (28%)**

\* One case was omitted in this test because of a defect in red-green color vision, as determined by the Ishihara Color Spot Test.

\*\* Analysis of responses showed that 3 out of 7 cases who chose A series really based their choice on other than purely hue factors.

TABLE 8  
DIFFERENCES ACCORDING TO TYPE OF SELECTION

	Experimental*		Control	
	Restricted	Broad	Restricted	Broad
Red sample .....	14	0	9	6
Green sample .....	14	0	3	12
Matching .....	12	2	5	10
"Reds" .....	12	2	4	11
"Greens" .....	10	4	1	14
Series pref. ....	7	7	0	15

\* One case omitted because of red-green blindness.

trating the mode of selection used by the subjects in the single tasks, also shows a marked preference for the restricted type of selection in the sorting tasks. Each subject's score includes the additional skeins added to their original selections when the skeins were presented by the examiner, with the query whether they did not also belong to this sample or to this group.

Analyses of the individual responses pointed to the fact that there existed common bases for the selection of the woolen skeins by the restricted groupings. The bases for selection as offered by the subjects in their sorting performances may be described in the order of the importance of their usage.

I. *Identity*. Only a few skeins were selected because of their marked identity to the sample, or, in tasks IV and V, because the color name was restricted to a particular shade of the given hue. *Examples*:

Case 14:

<p>Task I. Sample <math>RI_1</math> (Examiner picks all skeins of reddish hue, and asks subject whether they all do not belong.)</p>	<p>Responses <math>RI_2</math> <math>RI_3</math> <math>RI_5</math> "These may be (<math>RII_2</math> <math>RIII_1</math> <math>RII_4</math>) but they're another shade. These vermillion (<math>RI_4</math> <math>RIII_3</math>)."</p>
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Case 9:

Task IV. Pick all reds. Responses  $RI_3$   $RI_2$   $RI_1$

II. *Brightness Differences*. Only a few identical shades were chosen as of a particular hue. All other skeins which should be included within the same hue classification were considered as "light" or "dark," and in no way related to the particular sample or color name offered. *Examples*:

Case 5:

<p>Task II. Sample <math>G\ IV_7</math>.</p>	<p>Responses <math>G\ IV_5</math> <math>G\ IV_4</math> <math>G\ IV_3</math> "These should go separate because they are darker (<math>G\ III_3</math> <math>G\ IV_1</math> <math>G\ III_4</math>)."</p>
--	--

Case 15:

<p>Task IV. Pick all reds.</p>	<p>Responses <math>RI_3</math> <math>RI_2</math> <math>RI_1</math> <math>RI_4</math> "The others don't match, they are much lighter."</p>
--------------------------------	---

III. *Utility*. The reasons for selection on a utilitarian basis appeared particularly in tasks III and VI. Selections made were based on "color contrast," "that is good for a sweater and skirt," "none of them are a good match," "this has not enough variety," etc. *Examples*:

Case 3:

<p>Task III. Six matching problems, in terms of either hue or brightness.</p>	<p>Responses: Three of the six problems were matched in terms of brightness—"They make a good color contrast."</p>
---	--

Case 1:

<p>Task III (as above.)</p>	<p>Responses: Four of the six problems were matched in terms of brightness relations: 1. "This is a good combination for sweater and skirt." 2. "These look nicer than the other combinations." 4. "This is a better combination for knitting." 6. "This is a good knitting contrast."</p>
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IV. *Lack of Identity*. Bases given for refusal to match, in III, and for a complete rejection of similarity of cohesion, in VI, were

based on the complete individuality of the single shades. In task VI, the scale of reds was considered as a group of different colors, just as the second group of varying hues, to a number of subjects. The responses were that neither of the groups belonged together.

*Examples:*

*Case 8:*

Task III (see above). *Responses:* None of the six problems were matched either by hue or brightness—"No, they can't go together at all, they are all different colors."

*Case 15:*

Task VI. Which of these series belongs together better?

*Responses:* "This one does, it has more variety in it (six different hues). No, no, neither of them belong together, they're all different colors."

V. *Language Association.* Restricted association was explained, in some cases, as dependent upon the relationship of a particular shade and its language equivalent, or color name. Thus, a light green shade was not included in the "greens," but was separately placed as a "light green," having nothing in common with the "greens." *Examples:*

*Case 6:*

Task IV. Pick all reds.

*Responses:* RI<sub>1</sub> RI<sub>2</sub> RII<sub>1</sub> RII<sub>3</sub> RI<sub>4</sub> RI<sub>5</sub> RII<sub>2</sub>

*Exam.* "What about these (RII<sub>4</sub> RII<sub>5</sub> RIII<sub>1</sub> RIII<sub>2</sub> RIII<sub>3</sub> RIII<sub>4</sub> RIV<sub>1</sub> RIV<sub>2</sub>) aren't these red?"

*Response:* "Only these (her earlier selection) are red, lighter or darker, but these (examiner's additions) aren't red at all."

*Exam.* "Haven't they any red at all?"

—"They aren't red, they're reddish."

"Don't they belong with the others?"

—"No."

*Case 8:*

Task VI. Which group seems to you to belong together better? Why?

*Responses:* "This (the row of reds). Because this is red (RI<sub>1</sub> RI<sub>3</sub> RIII<sub>2</sub>) and this is light red (RII<sub>4</sub> RIII<sub>2</sub> RIV<sub>1</sub>)." (He divides the reds into two groups, three skeins in each.)

"This is red, dark. This is red, light color."

*Exam.* "Would you not put both together if they're all reds?"

—"No, because this is dark and this is light."

### THE STICK TEST

The Stick Test<sup>1</sup> involves the copying and reproducing of figures made by the setting of small sticks, 3 inches in length each, into various figures. The procedure of this test is as follows: In order to ascertain that the patient understands the task he is to perform,

<sup>1</sup> Cf. Goldstein, K. and Katz, S. The Psychopathology of Picks Disease. 1937, Arch. Neurol. & Psychiat, 38: 473-490.



he is first asked to copy the figure made by the examiner, while he is looking at the sample figure. A single stick is used at first, then two sticks in different figures, then three, and so on. When copying a figure, the patient is each time asked if the response is exactly like the stimulus figure, if it is correct. Upon certainty of his understanding the tasks, the examiner then gives an additional group of figures for copying, and then instructs the subject that this time he is to do the same thing, except that he will look at the figure first and reproduce it only after it has been removed. The stimulus figure is then constructed within the subject's view, and exposed for five seconds. It is then removed and the subject is given the exact number of sticks needed, and asked to make the figure he has just seen. The reproduction tasks, as do the copying tasks, also begin with simple figures, such as one and two sticks, and proceed to the more intricate, using three, four, five, etc. Whenever more than four sticks were used in constructing the figure, 8-10 seconds' exposure was always permitted.

The types of figures offered by the stick arrangements fall into two general classes, each of which can be again divided into two additional classes: Familiar figures, simple or fairly complicated; and Unfamiliar figures, which may also be simple or fairly complicated.

TABLE 9  
PERCENTAGES OF ERROR MADE IN FAMILIAR AND UNFAMILIAR TASKS IN REPRODUCTION SERIES

Subject	Experimental Group			Sub- ject	Control Group		
	Famil.	Unfamil.	Total		Famil.	Unfamil.	Total
1 .....	5%	16%	21%	1	5%	5%	10%
2 .....	0	0	0	2	0	0	0
3 .....	0	0	0	0	3	0	0
4 .....	2	30	32	4	0	.05	.05
5 .....	3	15	18	5	0	.08	.08
6 .....	30	37	67	6	0	0	0
7 .....	0	22	22	7	0	0	0
8 .....	11	25	36	8	0	0	0
9 .....	20	20	30	9	0	0	0
10 .....	0	.06	.06	10	13	16	29
11 .....	30	50	80	11	0	.05	.05
12 .....	20	40	60	12	0	0	0
13 .....	23	55	78	13	0	0	0
14 .....	0	.05	.05	14	0	0	0
15 .....	8	23	31	15	0	25	25
Average .....	10.13%	22.88%	33.01%		1.2%	3.07%	4.23%

Per cent error is taken as of the entire group of tasks given to the patient. It should be remembered that the Familiar and Unfamiliar Groups each contain but 50 per cent of the entire group of tasks.

The succession of the stimuli was arranged so that an equal number of both familiar and unfamiliar stimuli of the two groupings would appear in the reproduction tasks. Table 9 gives the individual responses, as seen in the percentages of error, to the two groups of reproduction tasks.

From the above table, we are able to note that there is a marked difference as far as success is concerned when we differentiate between familiarity and unfamiliarity in the stimulus figures. The experiencing of familiarity in the figure to be reproduced was found to be the most frequent basis for a successful response on the part of both experimental and control groups. However, we found that there was a marked tendency for subjects of the experimental group to seek the experiences of familiarity even in those figures which did not offer them, we believed, such opportunities. Thus, the trend of the subjects of the experimental group was towards the familiar experience generated by the stimulus figure, whereas the subjects of the control group did not show any trend in this direction. The latter frequently found that, when presented with the stimulus object, they had no difficulty at all with the solution. The percentage of error of the above table offers a marked difference in the totals of the two groups. The average error of 33.01 per cent of the experimental group for the entire series, may be compared with an average of 4.28 per cent error for the control group.

In dividing the stimulus figures into the two groups of familiar and unfamiliar elements to be experienced, we note again a marked trend in the differences between the two groups of subjects when viewing the figures of error of the unfamiliar elements. Here, an average of 10.13 per cent error may be compared with an error average of 22.88 per cent. These trends point rather to the definite attitude of seeking a familiar experience in the objects presented to the subjects of the experimental group, when, for example, such experience does not appear to exist. A definite example, presented in a group following shortly, demonstrates that Case 2 of the experimental group was successful in all her responses. Analysis of her responses shows that each and every stimulus object held a meaning for her. To the examiner, the meaning may have seemed quite at odds with reason, but nevertheless, for the subject, it was her way of successfully tackling the problem.

Table 10 illustrates a particular symptom which occurred in both parts of the test, especially in the experimental group. This aspect, which we call spatial disorientation, is found in half of the subjects

TABLE 10  
INDIVIDUAL RESPONSES SHOWING SPATIAL DISORIENTATION

<i>Subj.</i>	<i>Experimental</i>		<i>Subj.</i>	<i>Control</i>	
	<i>Copy</i>	<i>Reprod.</i>		<i>Copy</i>	<i>Reprod.</i>
1 .....	X		1	X	
2 .....	X		2	X	
3 .....	X		3	X	
4 .....	Spat. Disor.	Spat. Disor.	4	X	
5 .....	X		6	X	
6 .....	Spat. Disor.	Spat. Disor.	6	X	
7 .....	X		7	X	
8 .....	Spat. Disor.	Spat. Disor.	8	X	
9 .....	Spat. Disor.	Spat. Disor.	9	X	
10 .....	X		10	X	Spat. Disor.
11 .....	Spat. Disor.	Spat. Disor.	11	X	
12 .....	Spat. Disor.	Spat. Disor.	12	X	
13 .....	Spat. Disor.	Spat. Disor.	13	X	
14 .....	X		14	X	
15 .....	X		15	X	Spat. Disor.















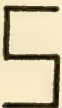

X Means satisfactory responses.






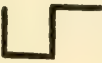



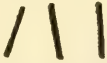
of this group, and in the two situations of copying and reproduction. What we mean by disorientation in space is the completion and placing of the figure at a position 90 or 180 degrees to the position of the stimulus figure. This symptom of response was noted in only two of the control group. It was also noted that these two individuals were the only ones in the control group with any appreciable amount of error. The spatial displacement is the factor which accounts for their errors. Thus, with these individuals it is not a question of familiarity or unfamiliarity as much as it is one of correct spatial localization. It should be mentioned that although this element of displacement is considered an error on each occasion, its frequency did not occur to the degree that it overshadowed the element of the experience of familiarity as demonstrated by the experimental patients. It appeared rather as a consequence of the attempts to familiarize the figure presented. This may be noted by the example furnished from Case 11, and that of Case 13.

The percentage of unfamiliar tasks presented in the reproduction series amounted to 50 per cent of the total tasks presented. In numerous instances where the subjects of the experimental group succeeded with the unfamiliar figures, it was seen that they were able to bring up, and, in some cases, to confabulate, the necessary experiences or meanings to assist them in their responses. Examples of such aids will be demonstrated.



The important aspects of behavior learned from the use of this test are the lack of orientation in space, and the dependence of the subject on a familiar meaning in the stimulus figure. Without the latter element, the experimental subject will fail in the task. This failure is not found to any degree in the control group. Insofar as orientation in space is concerned, we cannot say that it is a common factor found throughout all the experimental subjects. However, it is found in an appreciable number of this group, and only in two of the control cases. The factor of spatial orientation must be con-

	<i>Stim.</i>	<i>Reprod.</i>	<i>Remarks</i>
Case 2 no errors			"One quarter of a circle."
			"A circle with the side missing."
			"A circle with the bottom missing."
Case 11 90% errors			"An F."
			"F."
			"F."
Case 8 36% errors			"Mirror."
			"I forgot it, do it again!"

<i>Stim.</i>	<i>Reprod.</i>	<i>Remarks</i>
		"Two triangles, pointing up."
		"A mirror, a triangle here, and two sticks . . . a mirror and a little house."
Case 13 60% errors 		"Yes, I don't know the name, farmers use it to cut wheat." "(Seythe?)" "Yes."
		"A spade."
		"A ladder."

sidered together with the element of familiarity. In numerous instances where it occurs, it is found to coincide with the factor of familiarity, where the subject succeeds well in his reproduction or copying, by experiencing this familiarity of an object, which familiarity is exaggerated by the spatial displacement.

### THE FEATURE PROFILE

The Feature Profile of the Pintner Paterson Performance Series (59) was presented to the subjects. To prepare a definite set for the type of task presented to the patients, the Manikin (59), also of the Pintner-Paterson Series, was first presented. No particular differences were found in the Manikin. All of the subjects, both the experimental and control groups, were able to recognize what the Manikin would be if put together, and they did so with a minimal amount of difficulty.

The Feature Profile was placed before the patient according to the prescribed directions in the performance test manual, but the subject was first asked to tell what it might be when put together.

TABLE 11  
INDIVIDUAL RESPONSES TO PARTS OF FEATURE PROFILE

Subj.	Experimental					Control				
	Recog. Immed.	Profile Correct	Ear Correct	Attit. to Ear	Time (5 min.)	Recog. Immed.	Profile Correct	Ear Correct	Attit. to Ear	Time (5 min.)
1	X	X	Outsidet	Form	more	X	X	X	Both	less
2	X	X	X	Both	more	X	X	X	Both	less
3	X	X	Outsidet	Both	more	X	X	X	Both	less
4	X	X	X	Reverset	less	X	X	X	Both	less
5	X	X	X	Reverset	more	X	X	X	Both	less
6	X	X	Outside	**	more	X	X	X	Both	less
7	X	X	X	Lines	more	X	X	X	Both	less
8	X	X	Outsidet	Form	more	X	X	X	Both	less
9	X	X	X	Both	more	X	X	X	Both	less
10	X	X	X	Lines	less	X	X	X	Both	less
11	X	X	Outside	Form	more	X	X	X	Both	more
12	X	X	Outsidet	Lines	more	X	X	X	Both	less
13	X	X	Outside	Lines	more	X	X	X	Both	less
14	X	X	X	Both	less	X	X	X	Both	less
15	X	X	X	Reverset	more	X	X	X	Both	less
Totals	11	11	6	7*	12	15	15	15	0*	14

X Denotes success.

\* When only one definite element was utilized in solution of the ear parts.

\*\* This subject was unable to do anything at all with this test. Assistance on the part of the examiner was unavailable to aid in any solution.

† Solution was obtained by these subjects inside the puzzle after construction of the ear outside of the puzzle.

‡ Three cases of a Reverse solution of the ear parts were noted. This refers to the fact that the ear was solved correctly but was upside down in the puzzle, a fact which the subject did not recognize except when told of it. This will be elaborated in the text.



Following his response, the subject was then asked to put the puzzle together. If there was no success forthcoming, the examiner placed one part of the profile for the subject and asked him to complete it. Assistance varied with the ability of the subject. It was generally found that the subjects, with rare exceptions, tried to fit the profile elements into place before they made any attempts to solve the ear task. No assistance was given in the placing of the ear pieces, except after a period of failure, when the subject was asked to put these parts together outside of the puzzle, and then to repeat the task inside of the puzzle.

In order to achieve a successful solution, it is necessary to pay attention to both the form of the blocks and the lines drawn on these blocks, forming the ear. Thus, in correct placing of either the profile or ear parts, it is essential that the subject have the ability of attending to the two elements necessary for solution or to be able to shift easily from the form element to the figure or "line" element with adeptness.

#### ANALYSIS OF RESULTS

Table 11 illustrates the classification of the individual responses under the various groupings which appeared as of significant consideration in this test.

Summaries of the groups showing the methods of approach of the tasks of the Feature Profile are presented in Table 12.

TABLE 12  
GROUP TOTALS IN RESPONSES TO THE FEATURE PROFILE

	<i>Experi- mental</i>	<i>Con- trol</i>
Recognition of Figure immediately .....	11	15
Placement of Profile without aid .....	11	15
Placement of ear parts without aid .....	6	15
Placement of ear parts outside of figure .....	7	0
Success inside figure, after success outside figure .....	4	—
Attempted solution directly by attending to one element of the ear parts .....	7	—
Solution in "upside down" or reverse .....	3	0
Completion of test within five minutes .....	3	14

The element of recognition of the figure before any attempts at solution are made is evidently of little differentiating value insofar as the two groups are concerned. This may be seen in the larger number of successes in the placing of the profile. To some degree, it is also of value in recognition, when the ear is correctly interpreted.

However, though recognition is of assistance in the solution of the ear task, it does not always aid. This is apparent in the fact that seven of the experimental group attempted solution by only one of the two necessary factors leading to a correct completion. Added to these seven, are the three cases whose solution placed the ear in a reversed position, which they believed to be correct. Thus, a total of ten of the experimental group were unable to solve the ear task of the Feature Profile because of the inability to see the true relationship of the two elements needed for correct solution.

The standardization of this test allows a maximum of five minutes for solution. In the present study, we note, in accordance with the quantitative element of time, that only three of the experimental group were able to complete the test within the required time limits, whereas as many as fourteen of the control group were well able to do so.

#### RORSCHACH INKBLOT TEST

Some determination of the personality picture of these cases appeared desirable. A measure of the emotional status and its concomitants was necessary in order to determine what objectivity might exist to substantiate various emotional changes described in patients with frontal lobe involvement (*cf.* Chapter I). The Rorschach<sup>2</sup> Inkblot Test was selected as the method by which such a picture could be determined without too much dependence upon factors involving reading or writing on the part of the subject. It was believed that a test such as the Rorschach would obviate many language difficulties. All statements made by the subjects were recorded verbatim, and cases where a language other than English was used were translated literally.

This test was administered as follows:

1. The spontaneous responses of the subjects.
2. A repetition of the cards for delineation of the exact parts of the inkblots selected as the basis for the particular responses.
3. A second repetition of the cards for determining factors such as clarification, omission, suggestion; and abilities such as the selection of wholes or details, which were not apparent on the first or second presentations.

Oberholzer (53), in an application of the Rorschach Inkblot method to organic cases, concluded as follows:

1. These patients are unable to synthesize well.

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<sup>2</sup> Rorschach, H. *Psychodiagnostik* (Zweite Auflage). Bern, Hans Huber, 1932. Pp. 230.

2. They believe the inkblots represent definite objects.
3. Their associations are poor and uniform, frequently marked by perseveration.
4. Their reaction time is lengthened.
5. They give a large number of original responses, which are, however, of poor quality and inadequate.
6. The relative number of responses to whole blots and parts of them do not differ from those of normals.
7. Cooperation and interest are not diminished.
8. The introversive part of their personality diminishes while the extra-tensive increases.

These conclusions of Oberholzer's were verified, in the main, by studies of Piotrowski (60, 61), who used the same method with a series of organic cases, comparing them with non-cerebral and hysterical cases. As Piotrowski found, and as was found in the present experiment, not every patient possesses all of the characteristics implied in Oberholzer's conclusions. Piotrowski believed that greater precision was needed to make the interpretation of the Rorschach more uniform. On this account, he selected ten signs of abnormality from the responses obtained in his series of organic cases, in order to differentiate the cortical-subcortical group from a non-cerebral organic group and from a group of hysterical patients.

The criteria used by Piotrowski are those utilized in this experiment. It was believed that changes which take place in the human personality should, in accordance with the views of personality change in frontal lobe lesions, manifest themselves more markedly in such disease conditions than elsewhere. To allow for suitable comparisons and uniformity, the present author believed it would be of value to follow the methodology of description and interpretation devised by Piotrowski. A second consideration favoring uniformity is the fact that many of Piotrowski's organic and non-cerebral cases come from the same laboratory as the cases of the present study.

The ten signs of abnormality derived by Piotrowski and used as criteria in the present study are as follows:

- "R".....The symbol for the total number of responses when less than 15. Normals give usually 30 responses.
- "T".....The symbol for the average time per single response, when an average of more than one minute has been needed for each response.
- "M".....The symbol meaning that the number of movement



- responses has been no more than one. On the average, normal adults give at least three, rarely less than two.<sup>3</sup>
- “Cn”.....The symbol indicating that the record contains at least one color denomination. Normals give none at all.
- “F%”.....When the percentage of good form responses has been below 70%. Normals, according to Rorschach,<sup>3</sup> average around 80%.
- “P%”.....When the percentage of popular responses is below 25

TABLE 13  
RESPONSES GROUPED ACCORDING TO THE TEN SIGNS OF ABNORMALITY

<i>Experimental Group</i>											
<i>Subj.</i>	<i>R</i>	<i>M</i>	<i>T</i>	<i>Cn</i>	<i>F%</i>	<i>P%</i>	<i>Rpt.</i>	<i>Imp.</i>	<i>Plx.</i>	<i>AP</i>	<i>Tot.</i>
1	X				X		X	X			4
2		X			X		X	X			4
3		X			X	X	X	X			5
4	X	X			X		X	X			5
5					X	X		X	X		4
6		X			X	X	X	X		X	6
7	X	X			X	X	X	X			6
8		X		X	X	X	X				5
9		X	X		X	X					4
10	X	X			X			X	X	X	6
11	X	X	X		X		X	X			6
12	X	X			X	X	X		X		6
13	X	X			X			X	X		5
14		X		X		X	X				4
15	X	X			X	X	X	X		X	7
Total	8	13	2	2	13	10	11	11	4	3	Av. 5.1
<i>Control Group</i>											
<i>Subj.</i>	<i>R</i>	<i>M</i>	<i>T</i>	<i>Cn</i>	<i>F%</i>	<i>P%</i>	<i>Rpt.</i>	<i>Imp.</i>	<i>Plx.</i>	<i>AP</i>	<i>Tot.</i>
1	X	X						X			3
2											0
3	X	X									2
4							X				1
5											0
6	X						X				2
7	X	X									2
8	X	X									2
9	X				X						2
10		X			X		X				3
11		X									1
12					X						1
13			X		X			X			3
14		X									1
15	X										1
Total	7	7	1	0	4	0	3	2	0	0	Av. 1.6

X Denotes presence of sign.

<sup>3</sup> Rorschach, H. (*Op. cit.*).

	per cent. Normals generally offer about 30 per cent such responses.
"Rpt"	Repetition of the same response to several inkblots. Not necessarily perseverative or meaningless, but rather repetitive.
"Imp"	Impotence, or giving a response in spite of recognition of its inadequacy.
"Plx"	Perplexity associated with distrust of one's own ability and the quest for reassurance.
"AP"	Automatic Phrases or the frequent use of a pet phrase in indiscriminate fashion. Rather mechanical usage of a phrase despite the fact whether it is sensible or not.

The frequency of the existence of certain signs in preference to others is quite apparent.<sup>4</sup> In an analysis of the responses to the two groups, we have found the distribution of these Rorschach signs to show a particular trend.

TABLE 14  
GROUP COMPARISONS OF TOTALS OF EACH SYMPTOM

	<i>R</i>	<i>M</i>	<i>T</i>	<i>Cn</i>	<i>F%</i>	<i>P%</i>	<i>Rpt.</i>	<i>Imp.</i>	<i>Plx.</i>	<i>AP.</i>	<i>Ave.</i>
Experimental .....	8	13	2	2	13	10	11	11	4	3	5.1
Control .....	7	7	1	0	0	0	3	2	0	0	1.6

Tables 13 and 14 demonstrate that the experimental group, on the average, show 5.1 signs, as compared to an average of 1.6 signs among the control subjects. These results are comparable to those of Piotrowski (60) whose averages ranged 6.2 for the cortical-subcortical group and 1.5 for the non-cerebral and hysteria groups.

Analysis of the individual symptoms or signs permits us to stress certain particular elements in the frontal lobe group of our patients.

1) *M* Thirteen of the fifteen patients showed but a single movement response. This particular symptom fits into the category of a diminution of introversive elements, a trend towards the extra-tensive part of the personality picture, as defined by Oberholzer.

2) *F%* Thirteen of the fifteen patients showed a marked decrease in good form percentage. The tendency towards vague forms shows the poverty of quality and adequacy of response. It is rather significant of a lack of good synthesis and the inability to select the essential parts successfully.

3) *Rpt* Eleven of the fifteen patients found it necessary to repeat the same response to several inkblots, thus demonstrating the poverty

<sup>4</sup> The Rorschach records in this study were also evaluated by Drs. Z. Piotrowski and B. Klopfer, to whom the author is deeply indebted.

of associations and the inability to develop such associations successfully. Within this group of repetitive responses, we were able to note the belief on the part of the patients that the inkblots represented definite objects. Case 6: "A vase with flowers," "a flower pot," her response to Cards 1, 2, 4, 7, 8 (2), 9, 10. Case 14: "Spinal with matter," his response to Cards 3, 4, 6, 7, 8, 9, 10.

4) Imp Eleven of the fifteen patients demonstrated the existence of impotence or of giving a response despite a recognition of its inadequacy. This symptom again points to an inability to form good and useful associations, the inability to develop them and the inadequacy of their fitting the situation. Case 11: "Some kind of an animal but I can't tell what it is," his response to Cards 3, 5, 6. Case 5: "That looks like an animal to me, but I can't make them out," her response to Card 3, and "that looks like an animal to me, but what kind" her response to Card 9.

5) P% Ten of the fifteen patients were unable to give 25 per cent popular responses to the ten cards. This, too, fits into the Oberholzer grouping of an increase in the number of original responses, on the one hand, and, on the other, an inability to show sufficient participation in and adjustment to everyday life. This picture of decreased popularity in responses shows a tendency of the personality's difficulty in meeting daily adjustment needs.

6) R The existence of this symptom in eight cases, as compared to seven cases of the control group does not offer any definite or pointed trend as far as the particular lack of responses is concerned. However, if we consider this symptom in line with a grouping of the above-mentioned signs, then we may find it of value in diagnostic use. By itself, the total response record of less than fifteen responses offers little of significance, but when fitted into the above-mentioned symptom complex, we may be furnished with an additional clue to the poverty of associations.

From the analysis of the Rorschach records, we found a symptom-complex, in terms of response classification, which points to marked mental changes in patients with frontal lobe lesions. This symptom-complex contains in it such factors as M, F%, P%, Rpt, Imp, and in some instances R. This symptom grouping fits into the schema developed by Oberholzer, and that unified grouping of Piotrowski, wherein the latter has stated that a minimum of at least five of the ten signs must exist to point to organic brain involvement which leads to mental change.

Other factors have been found in our own cases, as in Piotrow-



ski's, but not to the same degree. Rather isolated instances of perplexity, reaction time increased, color denomination and automatic phrases were noted. The actual differences in these symptoms between the experimental and the control groups do not show marked trends to allow for each of these factors to be considered as valuable signs of mental change. However, it should again be held in mind that these strongly intrenched signs are valuable only in combination with the general symptom-complex, mentioned above, in pointing to organic involvement. Another element in the existence of such factors as increased reaction time, color denomination, perplexity, and automatic phrases is that dependent upon the severity of the disease condition. These patients admittedly are at a great loss for satisfactory expression and adjustment than are the less severe cases. In these individuals we are more apt to find such factors as perplexity and automatic phrases. Poor reaction time and color denomination appear rather as factors of the individual personality, in little manner significant of an organic basis for changes of behavior, as far as our study has shown. These elements do not agree totally with the work of Oberholzer (poor reaction time), and that of Piotrowski (color denomination), but such factors must be considered as well in the light of a pre-morbid personality because of the differences in the frequency of their occurrence in the different studies, although the methodology of administration and interpretation were quite the same. Piotrowski, in respect to color denomination, mentions the predominance of such responses among epileptics. Of our cases, there were two patients among the experimental group who were liable to such seizures: Case 1, who gave no color denominations at all, and Case 8, who gave three such responses. Both these patients were, in the past, susceptible to general convulsions. Of the control group, we again had two such cases, Case 4, subject to general convulsions, and Case 13, subject to Jacksonian seizures of one arm, neither of them giving any color denomination responses.

## CHAPTER IV

### DISCUSSION OF RESULTS

The psychological manifestations following an organic disease of the brain are manifold and varied. Many descriptions and interpretations have been offered, in agreement and disagreement, as to what such mental productions are. The description and understanding of such mental changes are absolutely essential for a true evaluation of the activity subserved by the human brain, especially that affected with a disease of an organic nature. It then becomes necessary to find means by which such description may become more uniform and more digestible, in order to allow for a better realization of the functioning of the substrate.

On this account, the present study was undertaken with the belief that the prime emphasis should be placed on the method of differentiating the behavior of those individuals suffering from disease involving the frontal lobes and of those affected with disease elsewhere in the nervous system. A qualitative study of behavior involving the higher mental processes appeared more desirable because of the greater need for understanding the changes which were supposed to exist. There is a good chance that careful description of behavior during test situations revealing a basic mental condition would demonstrate the Hughlings Jackson (35) precepts of "negative" and "positive" symptoms. Such attempts at differentiation have not been too successful because of their emphasis on "negative" symptoms to the detriment and neglect of "positive" symptoms. An example, however, of the success of qualitative evaluation may be seen in the descriptions of Head (33), though he did not use standardized tests. His investigations in the field of aphasia demonstrate the similarity of the methods: "All the tests in any one group are not of the same order of severity. Some can be carried out with greater ease and rapidity, even by normal persons, and these differences may become greatly exaggerated in pathological cases."

The results of this investigation will be discussed, first, in terms of the individual tests, and, second, in terms of all the tests as a group.

#### MODIFICATION OF THE KOHS' BLOCK DESIGNS

The common tendency of reaction, in both the experimental and the control groups of subjects, is to respond to the tasks in either of

two ways: 1) by breaking down the design into its component block elements, and constructing the required design by the single blocks; 2) by following the "figures" created in the design, thus building the "figure" of the design. On some occasions, the latter method leads to success, but more often it appears essential for correct solution to utilize the first of these methods.

The control group, although generally successful when starting with both methods, showed a marked preference for the first one. It was frequently noted that subjects of this group, beginning a task by means of the second approach, found it essential to shift to the first method of manipulation for success.

The attitude of the experimental group was such as to prefer the second method far more so than the first, with resultant failure because of an inability to veer to the first method.

A gradation of difficulty became apparent so that the design stimuli could be presented and greater "simplification" would be obtained for the response elements on the part of the subjects. This gradation is presented in the order ranging from the most difficult to the least difficult:

- 1) The design models drawn on cards, one quarter the size of the completed block models.
- 2) The design models drawn on cards, of the exact size as the completed block models.
- 3) The design models drawn on cards, of the exact size as the completed block models with black lines delineating the outlines of the single blocks.
- 4) The design models in blocks, exact duplicates of the completed block models.

By means of this new gradation of simplification in the presentation of the stimuli, it was possible to learn the extent of the ability of those individuals who demonstrated changes in their mental processes. Only one-half of the total tasks presented according to the original Kohs' method was successfully solved by the experimental subjects, compared to more than nine-tenths of the tasks correctly solved by the control group under the same conditions of presentation. (It is important to remember that the sample designs and only ten of the test designs were used in this study. The complexity of the last seven designs of the Kohs' test was entirely too difficult for the experimental subjects.) By this method, it was possible to find the occasions where such stimulus change and how much change was actually necessary for solution of the tasks successfully.



We were thus enabled to demonstrate that these individuals can solve these tasks. The added means of changing the stimulus designs permits this opportunity of viewing the actual ability of such persons whose outlook towards life is now changed, whose attitudes towards life are now narrowed, and whose behavior functions on a different plane of activity than ours.

#### COLOR-SORTING TEST

The responses to the Color-Sorting Test appear to follow a two-fold trend: 1) the mode of selectivity which follows what we call the "broad" basis of selection, or that which includes selection based upon the entire brightness scale of the particular hue; (2) the mode of selectivity which follows what we call the "restricted" basis of selection, or that based upon a narrow brightness range within the hue.

The first method of approach is that which we have found more frequently among the control group as compared to the experimental group. It has been noted, too, that subjects of the control group, at times, do make their selections in the so-called "restricted" fashion, yet when presented with the opportunity, they readily find themselves capable of accepting the broader basis for selection, including within this grouping, a greater distribution of the brightnesses of a single hue. The subjects of the experimental group, showing a decided preference for the "restricted" selection based rather on factors such as identity, near-identity, or utility, do not find it within their present capabilities to accept additional brightnesses to form groupings as broad in range as those of the control group. Despite the offering of additional skeins and the suggestion that they are reasonable for inclusion within the selected range, these subjects reject the added elements, believing that such groupings are quite unsatisfactory.

In examining the results of the individual tasks of this test, we are able to find definite differences among the tasks themselves. For example, in Table 7, the average of 7.3 skeins selected to match a given red sample, obtained in the control group, may be compared to the average of 16 skeins selected by the same group to match a given green sample. The same difference may be noted, in the control group, in the two tasks where the color names are used: an average of 9.4 "red" skeins, and an average of 19.4 "green" skeins. Thus we may note among adults with no signs of mental change differences referable to the factors of language, the color vocabulary (84).

The experimental group does show a similar difference in respect to the use of the color vocabulary, but apparently not to the same degree of spread obtainable in the control group. To the given samples, an average of 4.3 skeins was selected for the red, and an average of 5.3 skeins for the green. Where the language element was introduced by the examiner, an average of 6.9 skeins was obtained for the "red," and 10.6 skeins for the "green." The fact of the greater difference in choosing to a "green" color name, favoring the control group, may be due to the greater frequency of "green" in the color name; *e.g.*, Nile green, olive green, etc. as compared to red, pink, maroon, etc. Despite the differences relating to color vocabulary in respect to these particular hues and their relative meanings to the subjects, the differences between the control and experimental groups are well marked in all four tasks.

The matching task (task III) is a fertile field for finding the basis of selection of the subjects. We note, of the six problems offered, the control group chose on an average of 4.2 occasions in terms of hue equivalents, whereas the experimental group selected on an average of 2.05 times by the same criterion. Of interest is the fact that four of the experimental subjects rejected all but one single problem as having any relationship at all, be it hue or brightness, or any basis of belonging together. Nine of the control group chose all six matchings on the basis of hue equivalents whereas only one of the experimental group showed such consistency on the same basis. It was also learned, from this task, that the sensory elements of "lightness" and "darkness" were the more impressive factors in attracting the preferences of the experimental subjects as compared to the preferences of hue equivalents made by the control subjects, despite the marked differences in shade or brightness.

As has been noted elsewhere, Goldstein's (29) results have been substantiated in this study of the Color-Sorting Test. The basis for selection on the part of the subjects is dependent upon an attitude of the organism determining that approach which the subject has towards the stimuli of the test situation. The normal adult is capable of basing his selections on either of the two methods discussed previously, the "broad" and "restricted" methods, and can easily shift from the one to the other at will. However, it has been noticed, in this investigation, that the normal adult (control group) prefers to adopt that attitude which allows for the broader means of selection, called the more categorical or "abstract" attitude (29). This is in marked contrast to the "restricted" type of

behavior on the part of those individuals who have undergone some form of mental change due to a lesion of the centers subserving the higher mental processes. This attitude has been called the more "concrete" type of behavior, that which is more completely dependent upon the attributes of the stimuli as objects, rather than a more "willful" attitude towards selection as determined by the subject participating.

#### THE STICK TEST

Although the factor of familiarity presented in the Stick Test was objectively limited to a maximum of 50 per cent of the tasks, it was obvious that familiarity was created by the subject in order to aid his reproduction even in the unfamiliar tasks. This may be noted in the previously-mentioned examples.

Familiarity, by far, offered the best chances for success in reproduction, in contrast to lack of familiarity. There were only three subjects of the experimental group who were able to succeed with unfamiliar figures. The control group could respond successfully to both the familiar and the unfamiliar figures; they did not find any trouble at all as did the experimental group when unfamiliar figures were presented. This particular basis for success is important because again it points to the element of greater dependence upon the experience of familiarity in the stimuli on the part of the experimental patients, and much less dependence on this factor by the control group. The experimental group seems to show a greater need and dependence upon the use of the factors of experience, whereas the control group evidently does not need to undergo such experiences as a necessary prerequisite for correct solution of the tasks.

Again, a general dichotomy of behavioral approach appears dependent upon the attitude of the subjects wherein greater emphasis is placed upon the experience of familiarity of the stimulus-objects, and that attitude which places less demand upon the familiar experiences of the individual, the activity dependent upon his own processes of voluntary choice action.

#### THE FEATURE PROFILE

This test does not show the variety of behavior to such a degree as do the other tests of this series. It was possible, however, to divide the test into its component elements so that a gradation of the difficulty of the particular tasks was obtained. This order is given in a series from the least difficult to the most difficult:



1. Recognition of the figure before any attempt at solution.
2. Correct placing of the parts of the profile.
3. a. Correct placing of the ear parts outside of the puzzle, after failure inside of the figure.  
b. Correct placing of the ear parts inside of the puzzle, with or without a previous attempt outside of the puzzle.

Within the test it was found, in a comparison of the two groups of subjects, that no marked difference appeared in the first two tasks. In the third task, it became necessary to devise a means whereby solution would be possible for those subjects who were unable to place the ear parts correctly in terms of the presented elements of both the lines of the figure and form of the blocks, which, together, make the figure. Only six of the experimental group achieved success in solving the ear task directly. Seven of the subjects of this group needed a simplification of the task. This was done by having them put the ear together outside of the figure. The attitude so determined is by lines alone, so that the form element does not enter into the picture of solution. This added method was successful in all these cases. However, a second attempt to place the ear within the puzzle after the success outside the puzzle was correctly solved by only four of the seven individuals.

Another interesting fact which arose was the solution of the ear in "upside down" or reversed position by three subjects. They were quite satisfied with this solution. Only one of them (Case 5) realized his error after query on the part of the examiner, and was able to correct his error immediately. The other two subjects made no further attempts despite additional urgings. Only when told of the reversals, and to look at the examiner's ear, did they realize the fact of the reversal. The solution in terms of the lines is the more impressive element in this condition, despite the reversal. The correctness of the combination, in reverse fashion, is evidence in favor of the set towards the single attribute instead of the two attributes of the task. The solution then arises as a purely accidental factor. Thus, as illustrated in Table 11, a total of 11 subjects of the experimental group had difficulty with the solution of the ear task, pointing to this task as a possible differentiating factor in the test. The difficulty was found to be in the set of the patient towards one of the two elements necessary for solution of this part of the test. Only rarely, and that only by accident, is solution achieved by means of this set towards the single element, whether it be to lines or to form. The necessary approach to correct placing of this part of the problem is

the ability to work in terms of both elements of the task, an attitude which demands reflection or a simultaneous consideration of the two elements necessary to solve the task.

The control group, in all cases, successfully demonstrated this "double-attribute" approach, whereas only four individuals of the experimental group could follow this method of solution. Thus, a dichotomy of reactive set again makes its appearance, that of attending to the problem from the point of view of the discerning attitude, the simultaneous consideration of two elements of the stimulus object, as against one element of the same.

#### THE RORSCHACH INKBLOT TEST

In the Rorschach Test, it was found that a particular symptom-group could be isolated from the records. This symptom-complex, previously obtained in patients with organic brain disease by Piotrowski, was substantiated in this study of patients affected with disease of the frontal lobes of the brain. We learned that these patients show a marked tendency towards the extratensive behavior, that trend which leads away from the individual and more towards the outside world. Another element marked in these individuals is the lowering of the quality of their responses, demonstrating the lack of good synthesis and the inability to select the essential parts of the inkblot in a well-formed fashion. A third element, the repetition of a single response to several inkblots illustrates the existence of such factors as stereotypy and an inability to form satisfactory associations.

The factor of impotence, or giving a response despite the recognition of its inadequacy, is of extreme value when interpreted in terms of the elements of personality. Many descriptions have been written as to the marked indifference of the patients with frontal lobe lesions to their diseased state and to their surroundings. Such behavior may be understandable perhaps in terms of the impotence in their reactions. There appears to be some insight into the existing disability, but rather in terms of the organic disease; that is, they know they are ill, they have a paralyzed arm or leg, or have difficulty in walking, etc., but not mental change. The closest they may come to the latter is in terms of fatigue, or inability to concentrate, but never a true insight into an existing change of mental processes. Thus, this embryonic stage of insight, when contacting the environment, cannot be developed to allow for a satisfactory adjustment either to the environment or to their own condition. The result is

the continued abeyance of an adjusted attitude to the diseased state, manifested by this indifference. Another piece of evidence in this respect is the lack of a normal amount of popular responses.

The last of the marked signs of the symptom-complex of the frontal lobe lesion group, which, although not as frequent as the previously mentioned five symptoms, is to be given almost equal consideration, is that of the total number of responses. In itself, as we mentioned, this factor has little significance, but it is of value when manifested in conjunction with the other predominant symptoms. Here again, we have a striking factor of steretotypy of response, an inability to penetrate beyond the existing cloak of mental change so that full expression is obtained by the subject, with the result that their entire output is checked and restricted, not only in quality but in quantity as well.

#### GENERAL DISCUSSION

In a general comparison of the subjects in all the tests administered, we are able to note a particularly definite trend which runs through these tests. The consistency follows a pattern in response behavior which points to a general level of reaction, meeting the individual requirements of each test. If we omit the results of the Rorschach test for the present, and confine ourselves to the others of this group, we note one common element which appears as a basic factor to each symptomatic group. This element is that of the dichotomous approach on the part of the subjects as a whole. For example, we noted that the "figural" approach in the Modification of the Kohs' Block Designs was not productive of success without the essential "block" approach. In the color-sorting test, we found our subjects demonstrating a more "restricted" selection in their sorting activities, marked by a greater rigidity in their behavior when the question of accepting additional skeins to form a broader selection entered, as compared to the second method of a "broader" basis of selectivity.

In the third test of the group, the Stick Test, there again appeared to be a twofold manner of approach on the part of the subjects, characterized by success in the solution of problems when they experienced a familiar object as contrasted with the failure of the experimental group when no familiarity was experienced, and the success of the control group under the same conditions.

The Feature Profile, although not as highly productive as the other tests of the group, did offer a particular element where this



approach of a dichotomous nature made itself apparent, in the ear task. Here we noted that success was much more dependent upon the attitude which could accept simultaneously the lines of the figure and the form of the blocks forming the figure, whereas failure was frequently attended by the approach to but one of these two elements, either the figural elements, or the form elements—neither of which, by itself, would lead to success except accidentally.

In a general comparison of our two groups of subjects in the four tests described, we noted the general consistency of the behavior patterns of the two groups throughout. There are, of course, the exceptions within each of the groups, those individuals who are apparently more adept or less adept at particular tasks. However, the marked differences between the two groups tend to point towards the general differentiating character of the tests and methods used in this investigation.

The control group tends to prefer the attitude which allows for choice in behavior in all of the tests as compared with the restricted, narrowed type of behavior on the part of the experimental subjects. On the whole, all the tests in this section are able to show marked differentiation between the two groups. Our belief is that the accumulation of evidence is rather pointed in favor of differentiation.

The Rorschach Inkblot Test has given us a picture of the general attitude of each subject in terms of the criteria of this test. The criteria established for organic brain disease patients where mental change is part of the symptomatology have certainly been met. The interpretations of these criteria have not been speculative, but were based on previous experimental evidence (Oberholzer (53), Piotrowski (60)). This test, utilized as an additional method in such investigations, is rather an aid than a hindrance for determining the capabilities as well as the personality trends of the individual.

## CHAPTER V

### INTERPRETATION OF RESULTS

The particular elements stressed in this investigation were :

- 1) Method of approach.
- 2) The attempt to describe the behavior patterns arising in the subjects tested.
- 3) The determination of the consistency of these behavior patterns in a number of test situations.
- 4) The attempt to differentiate individuals suffering mental symptoms because of frontal lobe disorder, from another group with illness of different localizations, without mental symptoms, in a number of test situations.

We shall discuss each of these elements in turn. 1) The methodology in this study emphasizes the importance of more specialized methods of examination as a means for bringing to light those symptoms considered characteristic of frontal lobe disease of the brain, which are difficult to elicit because they are evokable only by special techniques. Our purpose in stressing qualitative analysis is to expose and describe the existence not only of "negative" symptoms, but as well the "positive" symptoms. Reviews of the literature have too frequently pointed out the lack of objectivity in the observations, the rather superficial interpretations of existing defects based on a combination of too meagre and inadvisable methods of examination, as well as second-hand information (relatives, etc.).

A second point, from the angle of methodology, is the lack of advantage to be obtained by a purely statistical study in this field, emphasizing the incidence of this or that symptom or the plus or minus records of capability. The importance of the qualitative analysis lies not only in the exposure of the "negative" symptoms, but in accurate descriptions of the behavior change and in the finding of those levels, where, by means of procedural changes in the tests, success is obtained by those persons who show behavior change.

2) The ability to describe accurately the behavior patterns which come as a sequel to a diagnosed frontal lobe defect is probably the most essential duty of an investigation in this field. The studies previously reviewed generally tended to point to the presence of symptoms, or of mental faculties, or they discussed the lack of defects in the mental sphere, associated with such organic illnesses. Since the general consensus of opinion favors the existence of mental change in

patients with frontal lobe lesions, there is a demand that such mental changes be more efficiently discovered and described.

Attempts at description of such mental concomitants of diseases of this region of the brain have already been made. Such work has been done by Goldstein (27, 28), Weigl (76), Penfield (56), and Brickner (13). Penfield offered a very interesting description of his cases, but did not attempt to go beyond general observations. Brickner tried to find a common element as basic to the behavior changes in his patient. He called this "a lack of synthesizing ability." This interpretation has been criticized as fitting more to symptom description than to a basic underlying form of behavior. Goldstein has called the inability on the part of his patients with such mental concomitants of the organic frontal lobe picture the lack of the "abstract" attitude. This attitude is normally in the possession of the adult unaffected by mental change. It is the attitude which demands the ability of voluntary choice action when there exist numerous ways of approach to the solution of a problem, and the correct selection of the best method fitting the present task for successful solution. The other method, which he calls the "concrete" attitude, is also in the possession of the normal adult. This attitude is rather dependent upon the given objects of the particular task. The normal has this ability as well as the "abstract" attitude, and he is able to succeed in his tasks because it is possible for him to shift from a "concrete" type of behavior to an "abstract" type. The patient with a frontal lobe disorder, however, has apparently shown changes in his abilities, and as the "abstract" approach is that of the higher mental processes, he loses this ability first. He is then left with what is called the "concrete" attitude. Thus, the individuals who utilize the "concrete" attitude solely are those who have demonstrated a lowering of the plane of intellectual activity in their behavior.

If we consider the discussion of the dichotomy of approach to the tasks presented earlier, it will be to our advantage to view this dichotomy as basic to the behavioral action of all our subjects. First, we noted that the control subjects, in some cases, would begin with an approach identical to that of the experimental subjects. Secondly, in order to achieve success, these subjects found it necessary to shift to the other approach, that approach which made solution of the tasks possible. The experimental subjects were more often unable to shift to this second method of approach. To alleviate this difficulty, for this seemed to be the underlying basis for their failure, the tasks



were presented so as to limit the difficulties to the extent that only a single element necessary for solution was placed before the subject. All other elements, which, when included within the requirements of the test were found to offer too great obstacles, were removed from the tasks. This analysis, pointing to the inability of the experimental subjects to select and respond correctly to the element necessary for successful solution, offers, we believe, a fruitful explanation for the behavior change to the tests given in this study.

3) Consistency of these behavior patterns in a number of test situations was found in the present experiment. We have noted, in our experimental group, the persistence of what might be called a more restricted form of behavior. For example, in the Modification of the Kohs' Block Designs, these subjects were more frequently responding to the "figural" elements of the tasks without reaching a correct solution. In the Color-sorting test, we noted the same group of patients responding to the sorting tasks with definite restrictions: the marked similarity of the given shades of the presented brightness. Particularly enlightening was the fact that hue, as such, was not the dividing line for sorting, as is more generally accepted among normal adults. The Stick Test, a simple test for successful responses, also developed this "restricted" type, of behavior wherein it appeared necessary for the subjects of the experimental group to "experience familiarity" in the reproduction of the test figures as a requirement for success. The Feature Profile again showed the behavioral change of the "restricted" type in the inability of the great number of patients of the experimental group to solve the ear task unless one of the two essential elements for solution was withdrawn. The last of the tests, The Rorschach, also demonstrated a consistency of behavior pattern to a large degree, although of a different nature than obtained to the previous group of tests.

If we combine the mode of behavior to all the tests of the group, there is no doubt but that we have found the behavioral picture described in the previous section to be consistent in a number of different test situations. We have also noted that in this consistency, there appears an underlying basis for the behavior change, the restriction to a given single element in each test (Ch. III). This fundamental factor for such behavior, secondary to mental change because of disease of the frontal lobes of the brain, appears to act as a common element, suitable for explaining the behavior to all the tests.

4) The ability to differentiate individuals suffering mental

change, as our patients, from another group with diseases located elsewhere in the nervous system, not encroaching upon the frontal lobes, appears to have been accomplished in this study. The two groups selected for study were differentiated according to the neurological estimations of disease localization and mental condition. Those cases where no doubt existed as to these criteria of differentiation were selected for study. The results of the testing program undergone by these subjects, point to the two general behavioral attitudes as differentiating the two groups of subjects. The group which we call the experimental subjects was unable, in general, to find it within their capabilities to respond with the attitude showing ability to choose their behavior reaction. They were generally incapable of voluntary choice of either the approach to take in solution, or the necessary element to be eliminated in the task presentation. When procedure was altered to require no choice of behavior, nor choice of the necessary elements of the task, there was definite success on the part of these subjects, too. Of the control group, it was found that the ability for this choice action in selection of the approach was well defined, that it was the most fruitful means used by this group in achieving success. When members of the control group, as they did on occasion, began a task following the approach of the subjects of the experimental group, the "restricted" method, it was obvious that they were capable of shifting to the other type of behavior, that necessary for correct solution for the problems. The experimental subjects differed in that they were unable to call upon this ability, and unable to shift.

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## CHAPTER VI

### SUMMARY AND CONCLUSIONS

1. A group of fifteen subjects, diagnosed by neurologists as having organic disease of the left or of both frontal lobes of the brain, with concomitant mental changes, was compared with a group of fifteen subjects, diagnosed as having organic disease located elsewhere in the nervous system, or of having functional changes, without mental concomitants, on a series of psychological tests.

2. The qualitative method of analysis was applied to the Kohs' Block Designs, the Color-Sorting Test, the Stick Test, the Feature Profile, and the Rorschach Ink-blot. The results of this method offered positive information pointing to factors of mental change existing in the patients with frontal lobe lesions, as contrasted with a control group which did not show signs of mental change.

3. By the use of the qualitative methods, it was learned that the subjects with frontal lobe lesions were able to solve the tasks when the latter were presented under "simplified" conditions.

4. The behavior responses showed ability to understand the instructions of the single tests. This was seen in the attempts to respond to the tasks in what appeared to be a "simplified" manner.

5. Two reaction patterns were seen in the responses of the subjects: A) The "restricted" form of behavior; B) The behavior which shows the ability to choose a course of action, and the ability to shift. The subject demonstrating mental change has lost the ability to choose a course of action and to shift, which we have called "abstract" behavior. He reacts with the "restricted" form of behavior, which we have called "concrete" behavior. Both forms of behavior are in the possession of the normal adult.

6. Consistency of the reaction patterns was found for each group of subjects in all the tests administered.



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